VOLUME 33, NO.4 • THE GEORGE WASHINGTON UNIVERSITY • EDITION 2, FALL 1986

MECH ELECIV

TELECOM-MUNICATIONS: GW ENTERS THE 21st CENTURY

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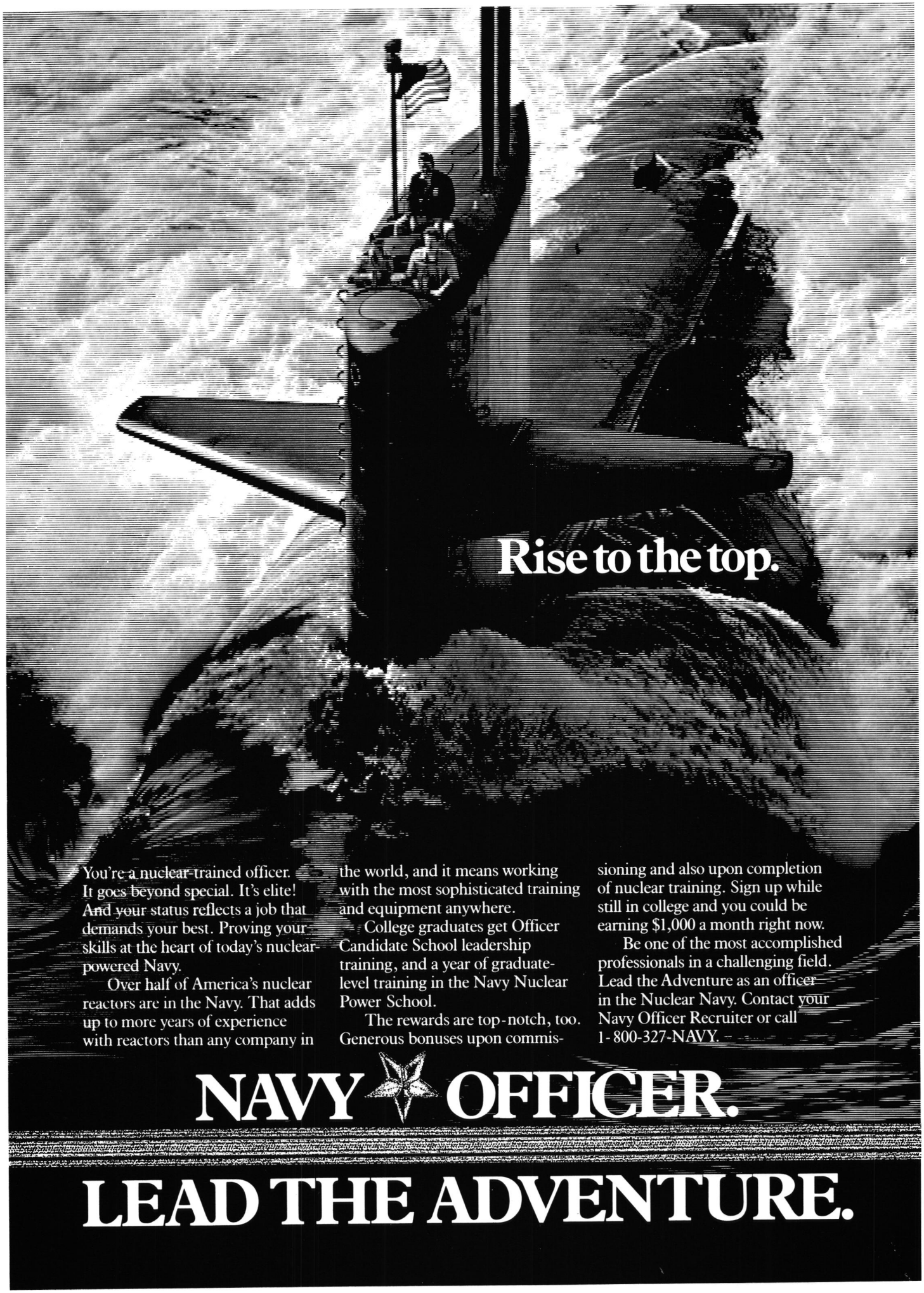
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Phone Wars: Long Distance Companies Fight for Customers

by Rose Province

The breakup of AT&T has led to a free-for-all competition between long distance carriers. Three of them—the "new" AT&T, MCI, and Sprint—have pulled away from the rest of the field. Can one of them gain an edge and become the premier long distance carrier?

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New Telecommunications System Brings GW Closer to the 21st Century

by Jeff Winbourne

Maybe you haven't noticed the two phones in your dorm room, but the new campus telecommunication system is very much here. When completed, it will provide a network for both telephones and information system equipment, putting GW in the forefront of a new information era.

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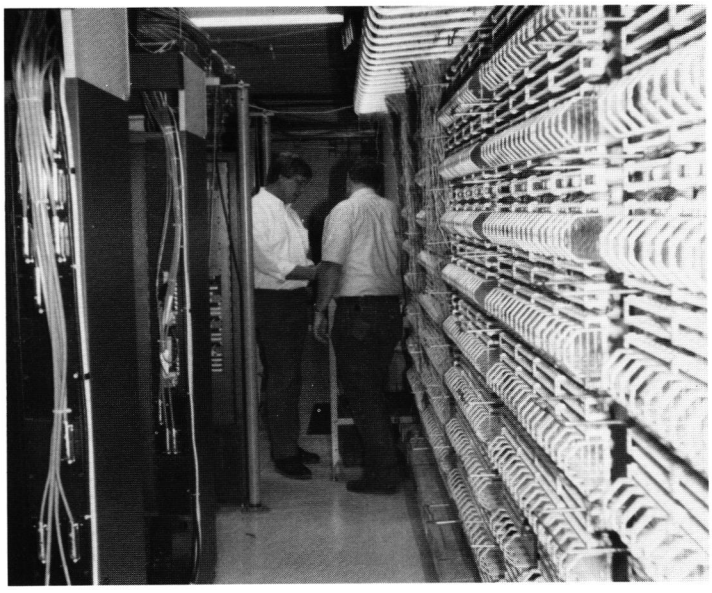

Replacing the Satellite Dish—NASA Plans its New Space Network

by Deirdre Maull

The political difficulties of placing satellite dishes in remote foreign countries have made NASA decide to build a space-based communications system. Begun in 1983, it will eventually provide the entire globe with almost unlimited communications coverage.

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COVER: The soon-to-be completed AT&T phone system will offer, as one of its features, the ability to tie into the school's computer network from any dorm room on campus. Photo by Euler V. Uy.

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FRENCH FLIRT IN BETWEEN BUSINESS ON NEW MINITEL SYSTEM

"Veux-tu q'on fasse l'amour ce soir?" ("Would you like to make love this evening?") French executive Nicholas Prinet reads this message as it flashes across the computer screen in his home. Dryly, he notes that it is signed "Sex Fiend."

Prinet, like 1.4 million other French, is a subscriber to the revolutionary new national telecommunications system — "Minitel." Minitel has transformed the once unreliable Paris telephone system into an efficient communications link. Gone are the days when, according to Monsieur Prinet, "it was easier to reach your girlfriend by the Paris Metro (subway) than to phone her."

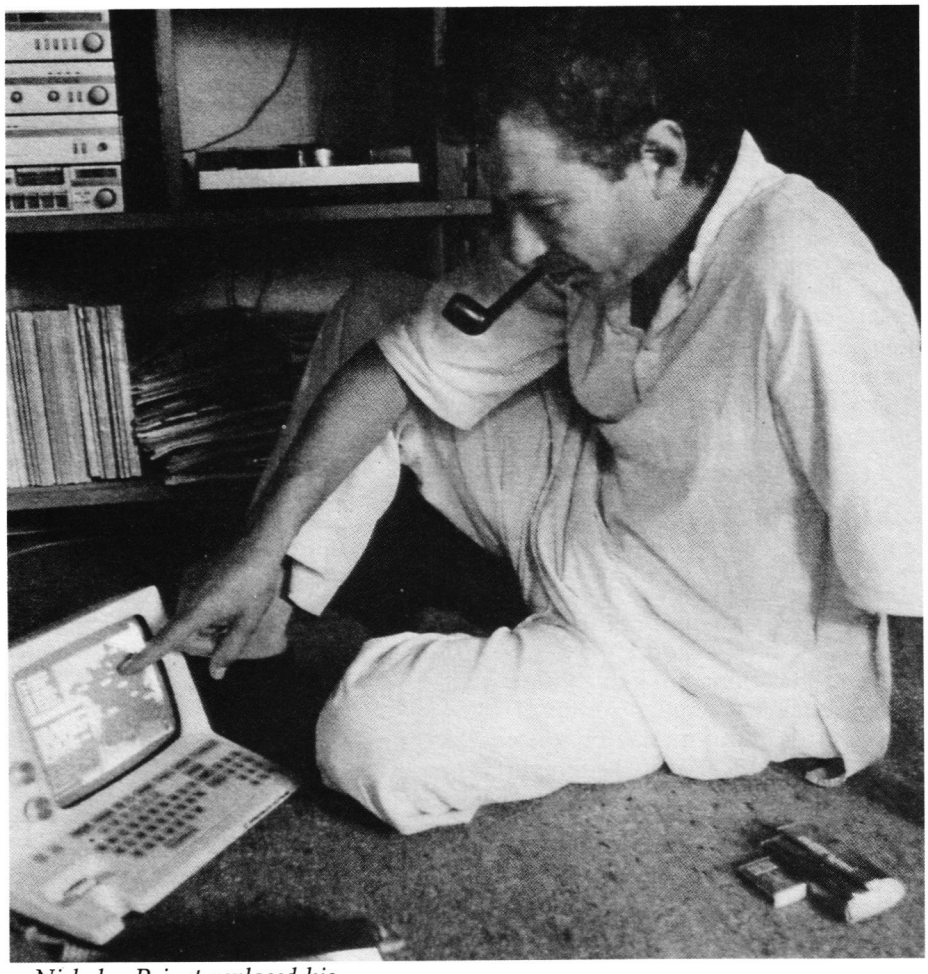
Minitel began as an idea to cut the costs of printing the voluminous French telephone directories. It was first installed on a trial run in Brittany in 1981, serving 1,500 customers. The city of Paris went on-line in 1983, and by May, 1985, the entire nation had access to Minitel.

Minitel is owned and operated by the state-owned telecommunications monopoly, the Postes Telephones Telecommunications or P.T.T. The P.T.T. provides business customers with a keyboard, screen, and modem, at the rate of 85 francs/month. Home service is free of charge. All customers, of course, are required to pay the telephone bills associated with this service, and this can become rather expensive. As M. Prinet related, his seventeen-year old daughter once ran up a 500-franc (about $75) bill just playing games!

Minitel offers a wide range of opportunities for its customers. In addition to the telephone directories, it offers banking, information, and entertainment message boards. Corporations can take advantage of its vast electronic mail service. Farmers can get up-to-date information on weather and crop conditions, as well as the current market prices. And, home users can read their morning newspapers, scan want ads, and enter into erotic telephone conversations, using pseudonyms such as Noir ("Night"), Phantom, and Sex Fiend.

You might wonder: Why hasn't a network like Minitel caught on in the U.S.? It's not because it hasn't been tried. Several multi-million dollar systems have been experimentally installed by Knight-Ridder, Inc. in Florida and by Times-Mirror, in California. Both were flops. In one whole year, the California system was able to attract fewer than 4,000 customers. As chairman of the project, Reid Ashe, in retrospective, put it: "We have learned that Americans absolutely will not buy a videotex terminal, and they are extremely reluctant to rent one." The one glimmer of hope lies in home banking services, being investigated by large banks like Chemical and Citicorp. Bank of America, in particular, has had the most success, now boasting 44,000 home banking customers.

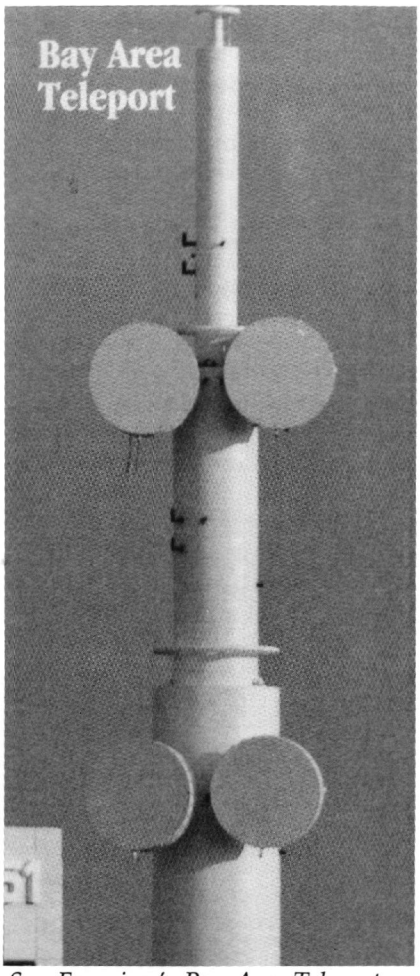
But in France, the future of Minitel looks very bright. Terminals are rapidly being installed in public places, such as train stations and shopping malls. New radical communication services are being planned that will allow cancer patients, AIDS patients, and battered wives to air their feelings to each other. Minitel is also moving abroad — up to



Nicholas Prinet replaced his unreliable French telephone with the revolutionary national telecommunications system, "Minitel." Courtesy of The New York Times.

now, 35,000 terminals have been sold to South America, Australia, the U.S., and other European countries. *C'est magnifique, n'est-ce pas?*

—Daniel L. Briller



San Francisco's Bay Area Teleport relays voice and data traffic by means of microwaves and fiber optic cables. Courtesy of High Technology.

Teleports Struggle to Survive

"DID you know that companies regularly use high-speed communications links to conduct their business? Well, a center of communication, managing voice and data traffic, is called a **teleport**. Most teleports are built away from dense populations and have high-capacity microwave or fiber optic links.

These concentration points for satellite communications perform multiple tasks. Satellite communications are relayed to customers by microwave fiber optic cables and by conventional telephone lines. Teleports operate local networks and some even have international services with such organizations as Intelsat's International Business Service, ATT, and Comsat.

Two types of teleports provide telecommunication services. One type, like N.Y. Teleport in Staten Island, combines telecommunications with real estate ventures. It is located in the midst of a busy area and is responsible for directing traffic for Comsat, the Catholic Telecommunications of America, and TRT Communications.

Another type of teleport totally concentrates on being a communication center. Such a center is Houston International Transport (HIT). They are not located in the heavily developed area of Houston, but are actually outside the traffic of the densely populated area of the city. This site has a satellite link with secure transmissions. They are used by Johnson Space Center, ATT long distance switching center, Southwestern Bell, and LDX (a fiber optic network operator).

The shared service of teleports is economically advantageous, but problems in building them have occurred, due to lack of enough capital for the expensive facilities. One in Texas failed totally, while another was largely unsuccessful and became only a video service. Even the N.Y. Teleport had several delays before finally becoming operational.

So, despite the many services that teleports provide, they still have to prove their worthiness. So far, only twenty-two teleports are successful; while others are still under construction. Whether they will be successful or not is yet to be shown.

—Lilimar Z. Avelino

Revolutionary Graphite Fiber Strengthens Composite Material

"ENGINEERS, listen in: there may be some use for your freshman-level chemistry course, after all. A researcher at Carnegie Mellon University, in Pittsburgh, has invented a chemical reaction that will produce more flexible graphite fibers for use in composite building materials. These fibers are a tremendous improvement over conventional graphite fibers, which tend to be too heavy, brittle, and dense for many applications.

Thanks to their flexibility, these innovative new fibers could vastly improve composite materials. Aside from being more flexible, these fibers are lighter, due to the plastic material they are combined with, less brittle, less dense, weigh less, and are more economical than existing graphite fiber composites. Due to the fiber's beneficial assets, breakage is reduced during production, and a greater number of low-density fibers can be packed into a composite, without adding excessive weight. In all, higher strength is attained, along with useful electrical properties.

The flexible fiber is created by a new process that requires the ordinary graphite fiber to be reacted at high temperatures with an inorganic reagent. A patent has been filed for this new process, and Deborah Chung, Professor of Metallurgical Engineering and Materials Science at Carnegie Mellon University, is now hoping to sell it to a major chemical company. Prof. Chung's process reduces the cost per unit volume of the composite by 20 percent, a significant savings for normally expensive composites.

Overall, Carnegie Mellon's flexible graphite fiber, with all of its innovative qualities, should contribute to the drive for lighter, stronger, and more economical materials.

—Swati Patel

VSAT SAYS GOODBYE TO TELEPHONE LINES

"ARE you tired of telephone lines? Are you fed up with those bills paid to local telephone companies? Well, there is a revolutionary way to interconnect and beam data between a host computer and its remote terminals - i.e., using communication satellites.

Continued on page 15

Phone Wars—Long Distance Companies Fight for Customers

by Rose Province

"WHAT do Joan Rivers and Cliff Robertson have in common? Besides both being actors, they are both spokespeople for major long distance telephone companies. The consumer today is bombarded in all directions with slogans, ad campaigns, and TV stars, all telling them to "make the right choice." It is safe to say that the foremost players in this competition are AT&T, MCI, and Sprint (in that order). The following paragraph is a short history on how these companies got where they are today.

AT&T (American Telephone and Telegraph Co.) was the countries oldest and biggest monopoly. But in January 1984, former Bell phone companies were separated from AT&T in the most extensive corporate breakup ever. Long before that, in 1969, MCI Communications Corp lead by William McGowan, their chairman, provided the first real competition for AT&T as they fought to break the monopoly. Since then MCI has grown by leaps and bounds, earning 12 times this year what they did in 1980.

The No. 3 long distance company is US Telecom and GTE Sprint, and though it serves only a small part of the long distance market, it is working hard to beat the competition through new technology.

WHO IS "THE RIGHT CHOICE?"

To promote competition, the Federal Communications Commission nurtured MCI and other new long distance companies. It did this by giving them huge discounts on connection fees to local phone networks—the major cost of operating long distance lines. The difference between AT&T and MCI's connection costs is decreasing from 70 percent to 20 percent over the next few years. This will be hard on MCI, simply because AT&T is twelve times its size. To add to MCI's troubles, AT&T is not backing down, i.e., they are playing the offensive role with their 37 billion dollars in long distance revenues. To keep on the edge, MCI will have to cut operating costs while managing growth, estimated at 33 percent for the next two years.

But never fear, MCI has a strategy: namely, it wants to transform its image from a cut-rate carrier to a complete supplier of long distance services. These services include computer communications, international long distance, and satellite transmission of video signals. A big part of their plan was the acquisition of IBM's satellite business systems. The idea is that IBM's reputation for quality will rub off on MCI.

Most experts expected AT&T's dominance to crumble by the 1990's, due to its enormous size

Chairman William G. McGowan is confident that his company, MCI, and not AT&T, is the "right choice." He hopes to have at least 2.9 million residential customers by the end of the year. Courtesy of Business Week.

U.S. Long Distance Fiber Optic Networks

NETWORK	PLANNED MILES	MILES IN SERVICE
U.S. Sprint	23,000	6,200
AT&T	10,200	5,200
MCI	7,000	2,500
National Telecommunications Network	11,160	4,123
Regional Networks	9,126	2,480
Total	**60,486**	**20,503**

Source: Fiber Optics & Communications Newsletter

GTE's Sprint is committed to the fiber optic revolution for long-distance telephone communications. Its 23,000 planned miles of cable are more than double what AT&T plans to install. Courtesy of The Fiber Optics & Communications Newsletter.

and slow corporate response. But AT&T still has 83 percent of the market and is more motivated now than ever. AT&T has many advantages, the main one being that it already has a vast network in place, while its rivals have to manage growth and construction programs. In addition it has a 11, 000 person- strong sales force, who are very knowledgeable over a broad range of areas. This service is very much appreciated by large businesses. "Others just don't have the resources", says Westinghouse Electric Corp. AT&T also totally dominates a three billion dollar market for Toll Free 800 calls. The 800 calls are billed "collect" to businesses, rather than to the individual callers who phone them. They are used mainly for telemarketing and reservation centers.

But MCI and Sprint are both ready to get in on the action. MCI is offering its own 800 service, which it plans to test with its customers this fall. MCI will charge less than AT&T for its service, and it will also provide features not available in standard AT&T service. These features include distance-sensitive pricing, no add charge for using the same number for in-state and out-of-state calls, volume discounts, and detailed information about calls. Sprint also plans to enter the 800 service market, early next year. The reason this market is so attractive to competitors is that it is growing at an annual rate of twenty percent.

Each corporation seems to be attractive to a particular segment of the market. MCI Corp. with prices 5 percent to 20 percent below AT&T's, is doing well with small businesses and residential customers who use long distance a lot. Sprint tries to sell to a younger more independent-minded customers with the slogan "When you've got Sprint, you've go the future on the line." But Sprint lost marketing momentum when it had to turn away customers, because its network was not big enough to handle them. Residential customers will not give Sprint the market share it needs. The company is counting on selling bulk long distance services to business customers. It hopes to lure them with the excellent transmissions provided by a high-quality fiber optic network.

FIBER OPTICS—ENTERING A NEW FRONTIER

U.S. telecommunication companies plan to triple their mileage of fiber optic cable by next year. Fiber Optic technology will vastly increase the capacity of the U.S. long distance telephone system. Some major advantages of this technology is that is cheaper to maintain than the current network, and it offers transmissions nearly free of distortion. One problem, though, is the immediate prospect for a long distance system with more capacity than is currently needed. Fiber optic operators could be forced out of business before they can turn the technology into profits. But risks must be taken in order to make gains!

Dozens of U.S. companies are rushing headlong to build fiber optic systems. U.S. Sprint Communications, who is leading the charge, will install a planned 23, 000-mile fiber optic system by the end of next year. This is a bold move to compete with AT&T, which has plans for a fiber optic

"Dozens of U.S. companies are rushing headlong to build fiber optic systems."

system about half as long. A good portion of the U.S. cable capacity will be on line next year as Sprint, AT&T, and MCI gear up for a new battle.

Fiber optics can transmit voice and data faster, and with less distortion, than current microwave systems. This is how it works: the callers voice is copied by electrical impulses called **voice signals**. These signals are converted into digital information. When computers are talking the conversation is already in digital form. A laser beam converts the digital code (a stream of "on" and "off" signals into light pulses that pass through the flexible glass fibers with almost no loss of information and no additional distortion. With light pulses shooting through the hair-thin fibers, at the rate of about 565, 000 bits of information a second, each pair of fibers can carry more than 8, 000 phone calls, simultaneously! This capacity is enormously greater than the microwave radio transmission system that now carries much of the nation's long distance traffic. It is very easy to reach the maximum capacity of microwave tower systems, and, after that, a corporation, for example, would have to build more of them to maintain their loads.

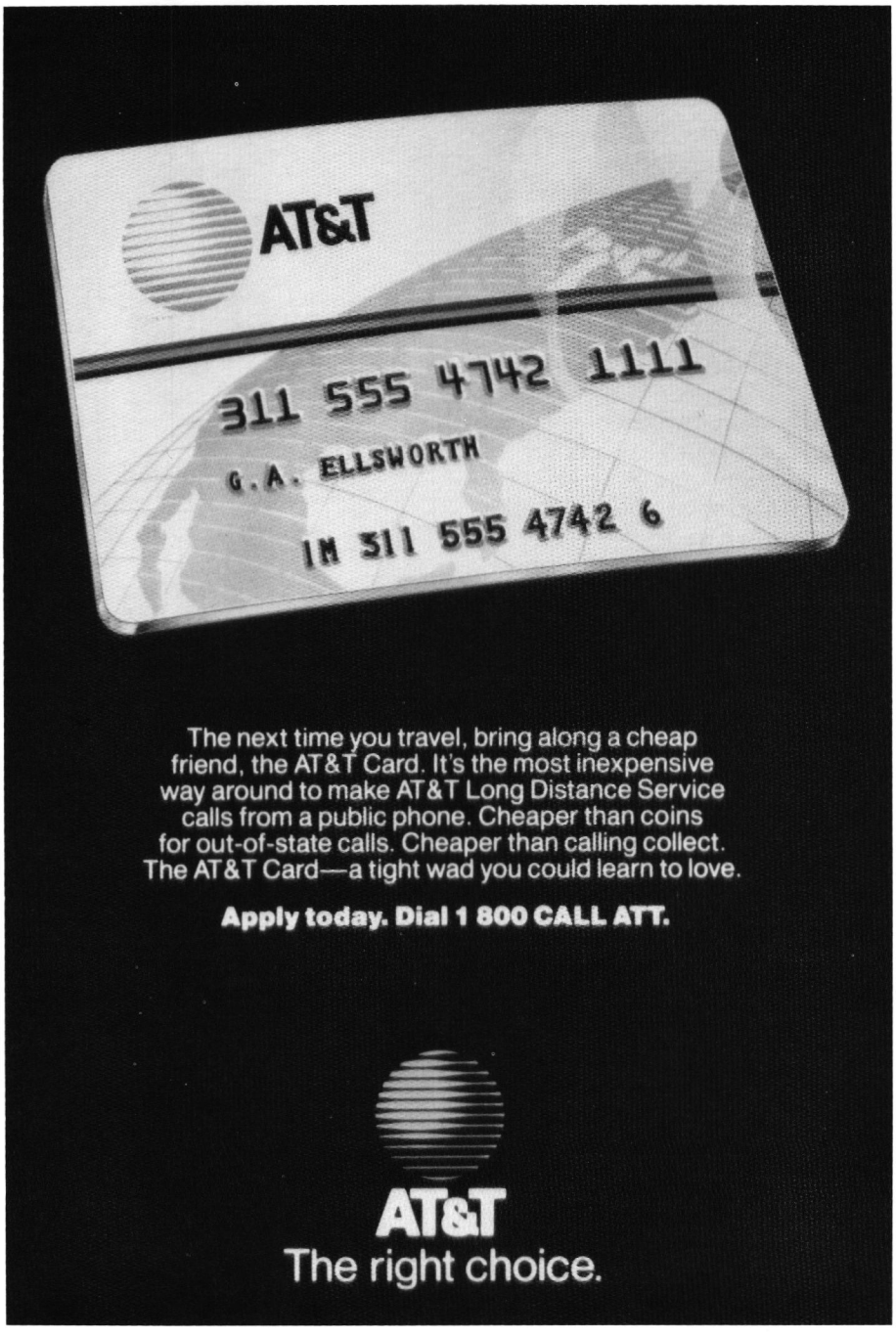
It is already possible to double the capacity of a given strand of fiber by simply enhancing the electronics. Future technological advances are expected to push the impulses even faster.

"THE better transmission quality of fiber optics is the market lure. Sprint has begun a multimillion dollar ad campaign touting the nations first all-fiber system. The ads explicitly compare the sound quality, but calls still must pass through the noisier non-fiber, non-digital equipment in the local phone companies; that is, until the local companies switch to the new technology.

Major fiber optic markets include high-speed data, communication, computer networking, and high resolution transmission for motion pictures and television. When used with computer services the extremely high speed links makes it possible to move massive data bases in minutes or less.

One benefit for customers, in the short run at least, will be lower telephone bills, especially in heavy-traffic areas, where most of the systems are concentrated. Competition will force system owners to aggressively bid for traffic to fill their new fiber optic pipelines.

The long distance communication industry is a perfect example of sophisticated technology put to use as the cutting edge of business competition. It will be interesting to see if fiber optics can give one company the edge, or if they will continue to compete just as fiercely in the coming years. ■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AT&T's huge advertising budget gives it a definite edge in the competitive market for long distance. Their portable calling card is a popular subject of their advertising displays. Courtesy of AT&T Communications.

NEW TELECOMMUNICATIONS TO THE TWENTY-FIRST

by Jeff Winbourne

"MAYBE you haven't noticed the construction crews all over the place or the two phones in your room, but since last summer the university has been installing a new telecommunications system. So, what's the big deal, its just a phone system right? Well, yes and no.

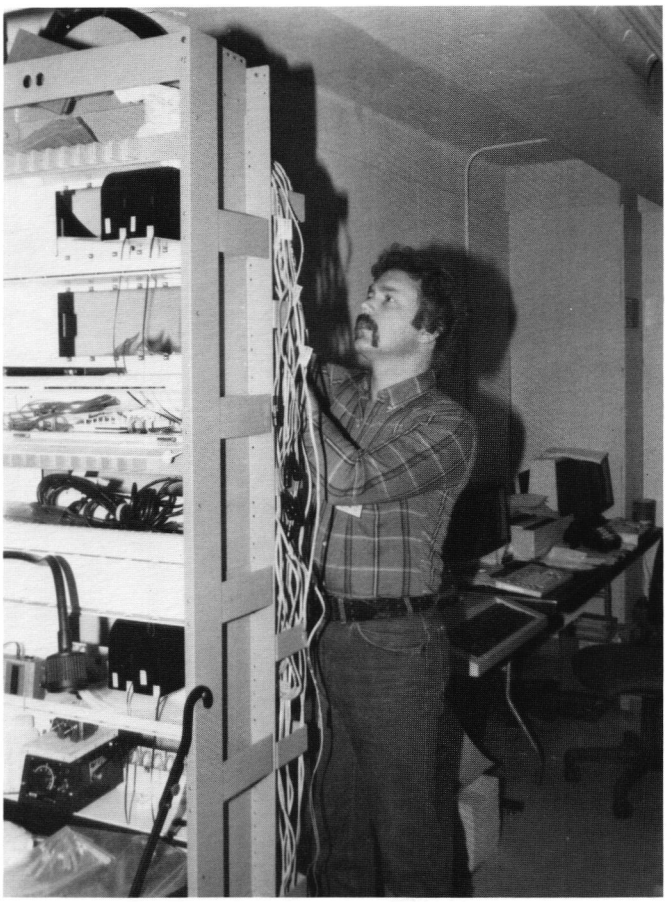
The system the school is getting will include your basic phone network with some new goodies, and will also have a bunch of other items thrown in.

One of these will be the new data transfer system or the Information System Network. (ISN). This will enable students, faculty and staff to access all the universities academic computing facilities from remote locations throughout the campus.

Another feature that will be available to faculty will be the video capability. Video tape, movies, and classroom instruction will be transmitted to classrooms outfitted to receive them. This will compliment already existing facilities for producing videotapes in the TV studios in Academic Center.

And let's not forget the telephones. The phone system will have a number of options not now available. In fact, it will more resemble what is currently available on the market from the phone company and then some.

These changes all started about three years ago with the ATT divestiture. At that time communication prices were predicated to skyrocket. For this reason, and the pressing need to expand data communications around campus, university officials decided to invest in a new system.



EULER V. UY

Installation of the new telecommunications system is expected to be completed in Spring, 1987.

According to Robert Longshore, director of telecommunications at GWU, "CP (the local phone company) didn't have the capability to give us the speeds and the flexibility at the various locations where we wanted to distribute data."

After an initial survey of communications needs on campus, bids were solicited from contractors. Five were submitted and ATT was selected for two reasons, according to Longshore. "One, they had the type of equipment we needed, equipment oriented toward the digital world. Secondly, they offered us the best price."

What will this $10 million contract with ATT bring us?

CHANGING THE PHONE SYSTEM

The phone system will provide the following new features:

- pushbutton operation;
- ability to place a call on hold;
- three way conferencing;
- call transfer capability;
- several programmable options including 'send all calls,' with which your calls will be automatically forwarded to

SYSTEM BRINGS GWU CLOSER CENTURY

The telecommunications center for the new network occupies an entire room in the Academic Center. In addition to possessing banks of switches and relays, it is completely computer-controlled.

another number you programmed into the phone. Another is 'call pickup' which will permit you to answer a call to someone else in your phone group (office, etc.), from your phone. Also, primary, secondary, and tertiarty call coverage can be provided. With this feature, the phone can be programmed to ring at up to three additional numbers, provided no one picks it up at a prior number.

Some other changes will occur to the system. These are a new exchange will be used by most of the university. According to Longshore, the old 676 exchange was being used up and the new exchange, which is not shared, will give more opportunity for growth. (The 676 exchange is currently shared with the World Bank.) The new exchange will be 994.

Dialing inside the University now requires the caller to use only four numbers. The new system will require you to use five digits to reach a number inside the university.

Long Distance service should be better also. Previously calls were routed to the CP downtown office before going out. Now they will go simply to the main switch in the Academic Center and then out.

Needless to say this phone system is more complicated and will require training in order to use. This service will be provided by the Telecommunications department to users as their new phones become operational.

INTRODUCING THE INFORMATION SYSTEM NETWORK

The new data transfer scheme, known as the Information System Network should bring wider and more flexible use of computers. Current plans indicate this network will become operational university wide sometime this spring. Students, faculty and staff will all be able to access the system in offices or dorm rooms. This is in addition to presently available use of phone modems.

When connected in to the network your PC or if you are working off of a main frame such as the 'VAX' you will be in position to 'speak with' any other computer that is also connected. This is in addition to using the campus computing facilities such as in Tompkins Hall.

For the School of Engineering and Applied Science, (SEAS), this will be quite a large undertaking. Already, according to Donald Huttenlocker, the Assistant Director for Research and Resources for SEAS, SEAS will initially have 220 activated computer ports installed in its facilities. These include offices in Gelman Library, the third, fourth, sixth and seventh floors of the Academic Center, Staughton Hall, Tompkins Hall, and DH House.

To use the ISN is not free. It will cost $25.00 per month per hook up. For SEAS, Huttenlocker estimated this would run $66, 000 annually . This amount will grow as the need for additional ports are identified.

As far as the video capability is concerned SEAS has plans in the works there, also. Each classroom or combination lab/class room will be outfitted with a hook up. Users must provide their own television for viewing.

Currently, the telecommunications department hopes construction and installation will be completed during the spring semester.

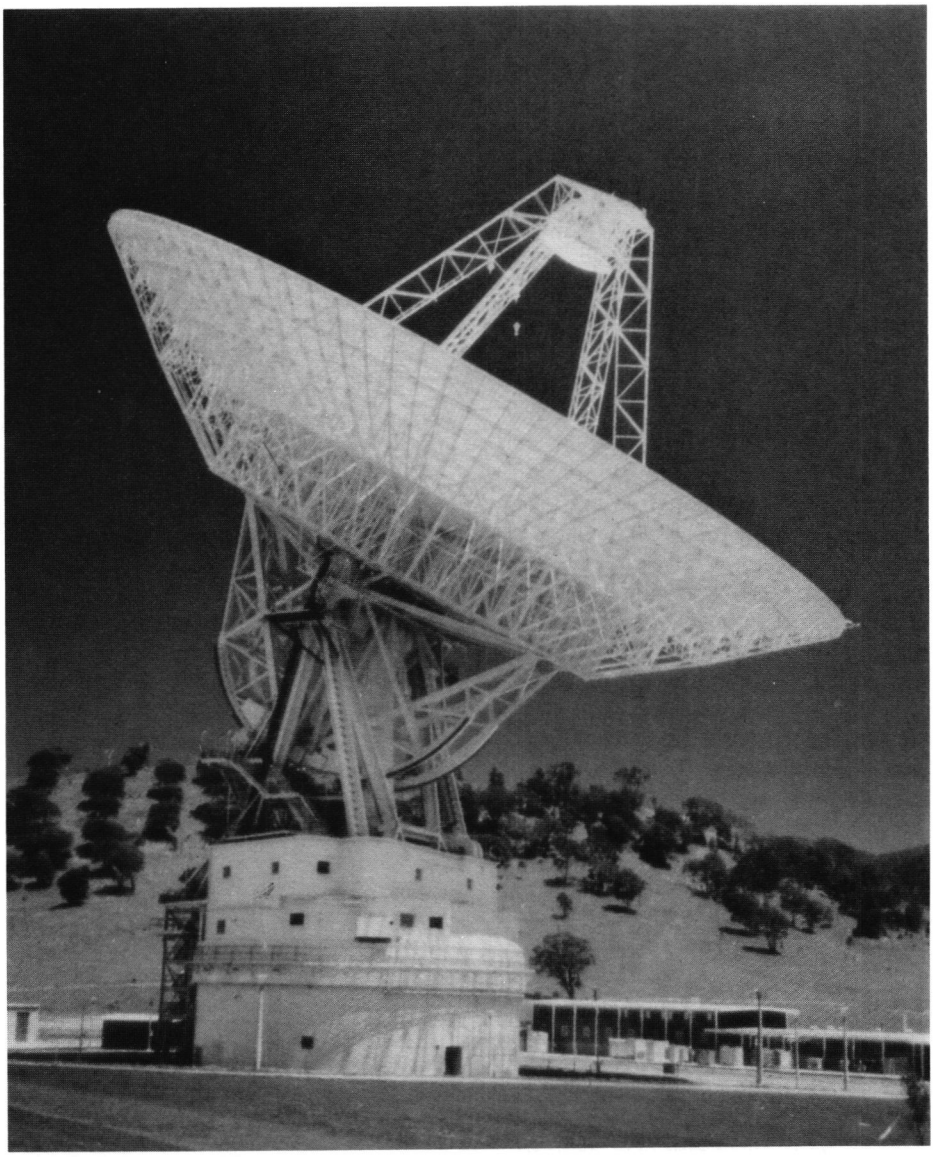
■

Replacing the Radar Dish:

by Deirdre Maull

NOWADAYS, it is not uncommon for your next-door neighbor to have a satellite dish on his front lawn for picking up TV channels. NASA, however, hopes to do away with almost all of its gigantic dish antennas, within the next 5-10 years.

NASA is building a new Earth-to-orbit and orbit-to-Earth communications link named "TDRSS." The letters stand for Tracking and Data Relay Satellite System. When completed, the system, together with its various support elements, will be known simply as the "Space Network." It will substantially increase information exchanges between low-orbiting spacecraft and the ground.



The deep-space dish at Canberra, Australia helps monitor the flights of NASA spacecraft. It is 21 stories high and weighs 8000 tons, yet it maintains a focusing accuracy of 0.005 degrees. Courtesy of Hispanic Engineer.

So far only one of the system's three planned communications satellites has been in place in orbit. When the system's other two satellites are launched, the completed Space Network will represent one of the biggest advances in space communications technology in the 1980's.

A new booklet by the National Aeronautics and Space Administration, entitled The Tracking and Data Relay Satellite System, describes this new and powerful communications capability. As is characteristics of most NASA publications, the booklet is readable, attractive, and useful to informed generalist and experts alike. The illustrations alone make the reading worthwhle. This article summaries the contents of the booklet.

In the early days of space flight, communication with orbiting craft was made possible by strategically placed Earth stations. They were scattered across continents, beneath the typical orbital paths of early spacecraft.

The construction, maintenance, repair, and operation of these Earth stations required negotiations with the governments of the various nations on whole territories these stations were built. Entry permission had to be obtained for U.S. personnel and equipment. Access could not always be readily gained, even though many of these countries took great pride and satisfaction in the role the stations gave them in early explorations.

Although these stations served the early U.S. space program well, they demonstrated severe

NASA Plans its New Space Network

disadvantages. Spacecraft in orbits of up to only a few hundred kilometers above the Earth's surface could communicate with these stations only sporadically.

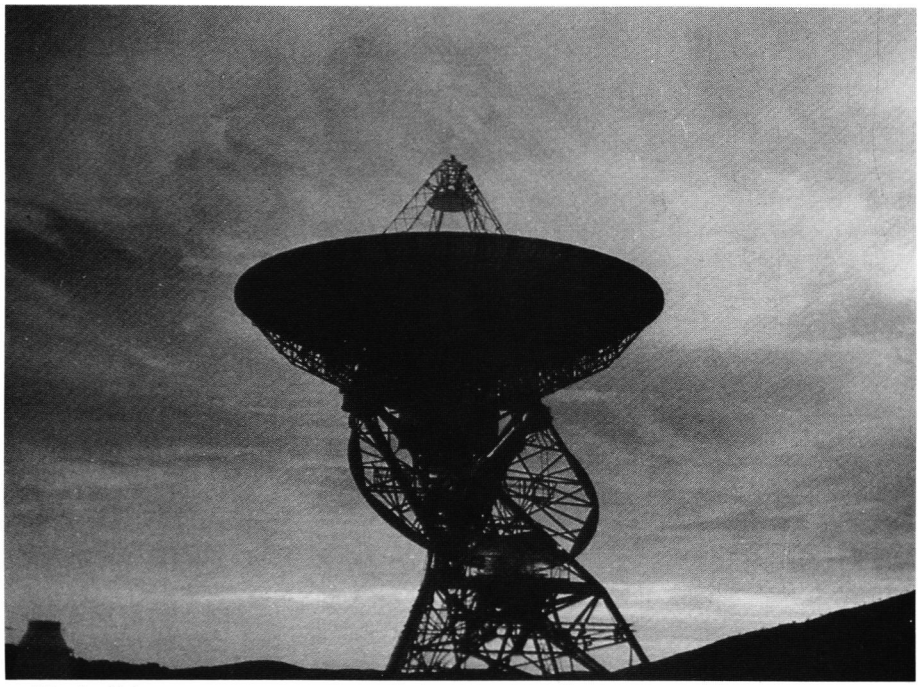
Communications was possible only from time a spacecraft rose above a station's horizon until it disappeared below the opposite horizon. Such overhead passes were typically only a few minutes long, and on most orbits a craft rarely passed more than a few stations. All U.S. manned spacecraft, except flights to the Moon, were placed in these low orbits.

These spacecraft, at altitudes of up to only a few hundred kilometers, were typically able to communicate with the ground no more than about 15 percent of the time. Thus, for '85 percent of each orbit, they were beyond any communication contact.

In the U.S. Mercury, Gemini, Apollo, and Skylab programs of the 1960s and 1970s, and the first several Shuttle flights in the 1980s, the combined communication time with all Earth stations averaged less than 15 minutes during each 90-minute orbit. Unmanned, automated spacecraft in low orbits fared no better, and some ground stations could monitor only two spacecraft at a time.

By the early 1970s planners knew that the network of Earth Stations would be inadequate for the Shuttle era. A fleet of Space Shuttles would carry into space a series of research instruments equal to a small research center. With crews of up to eight persons working in shifts around the clock, throughout eight-day or longer flights the Shuttle, voice and data communications would take on giant dimensions.

Many more ground stations would be needed. The capacity of the existing stations would have to



Hugh dish antennas, like this 85-foot one at Goldstone, California, pick up signals from the deepest regions of space. NASA hopes to replace most of these dishes with its the TDRS satellite system. Courtesy of Hispanic Engineer.

be significantly enhanced. Studies showed that even with these costly improvements the network of ground stations would still fall far short of the nearly continuous coverage desired for the Shuttle and other spacecraft at low orbital attitudes.

Furthermore, quick retrieval of telemetry data collected at the ground station scattered around the world would be needed. These data would have to be sent to the central collection points at high volume transmission rates. Costs of such a service would be very high.

Experiments demonstrated that a space-based system was feasible with available technologies. The envisioned system could meet all expected new requirements for communications, data acquisition, and tracking. Its projected costs compared favorably with the estimated expenses of upgrading and operating the ground station system. Moreover, only one ground terminal would be needed for global coverage.

The first satellite was launched on April 4, 1983. When the new system is complete, only a few ground stations will be retained. They are used by the Shuttle during its launches and landings when the flight position of the Shuttle antennas makes communication through the TDRSS satellites impossible. Also to be retained are stations needed to service spacecraft whose orbits are incompatible with the TDRSS.

A TDRSS satellite looks like a windmill, in the sense that it has four arms or paddles. Two opposing paddles are flat, square solar panels, measuring 3.8 meters on each size. The two other paddles look like upside-down umbrellas. They are parabolic dish antennas with diameters of 4.9

meters. They are adding new dimensions to space communications.

Holding thes paddles in place are booms of extruded beryllium, which form the arms and legs of an X. At the X's center other antennas of various shapes and sizes are attached, as well as the subsystems that control communications, electric power, satellite attitudes, and other essential functions.

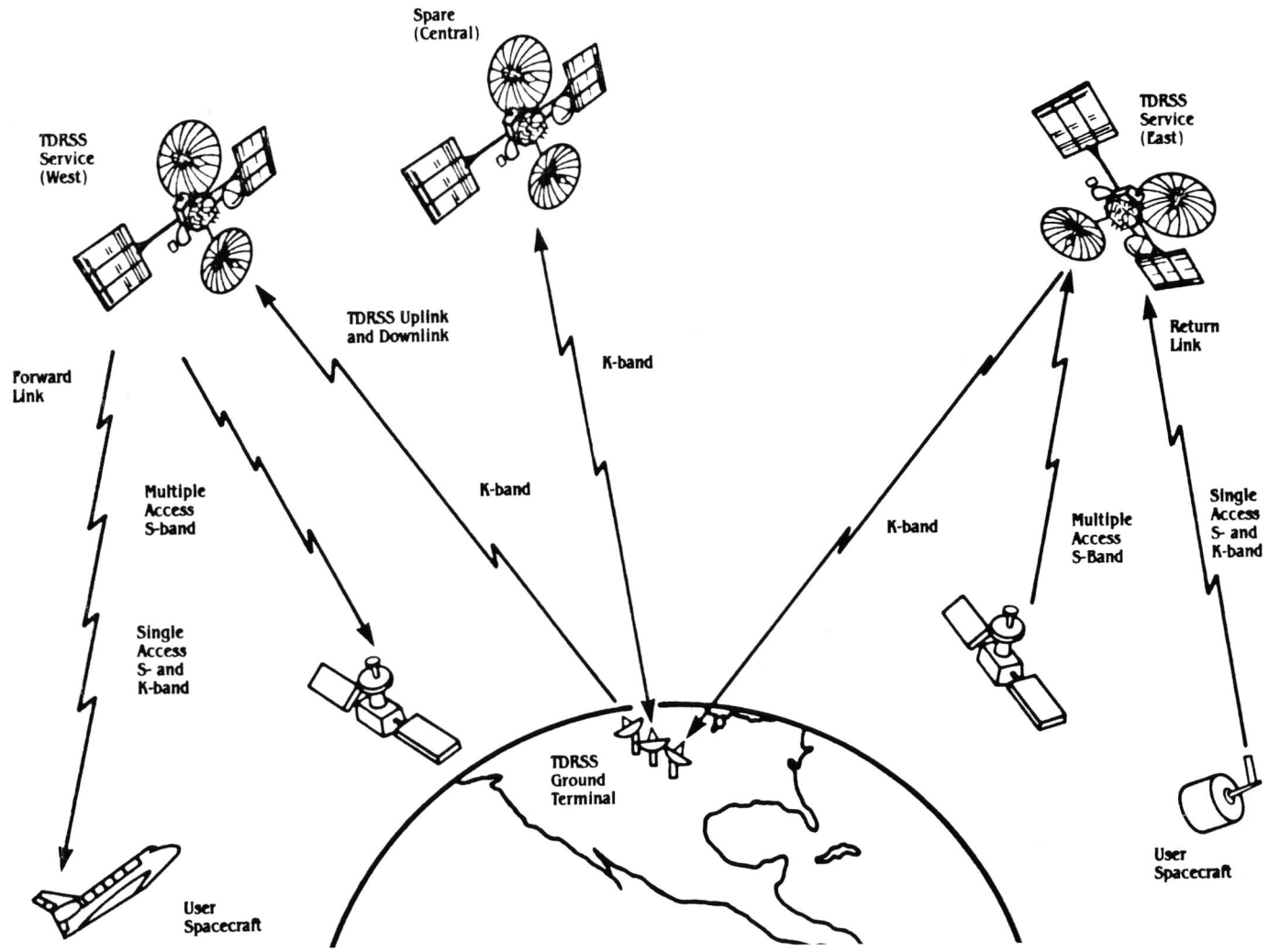
Three satellites like this one will make up the orbital segment of the Tracking and Data Relay Satellite System.

The satellite is currently in operation at an altitude of 35,680 kilometers above the equator. It travels in a "geostationary orbit" (also called geosynchronous orbit), meaning its movements correspond with the Earth's rotation. Thus, if it could be watched from the ground, the satellite would appear to be hanging in almost motion-free suspension above the Earth. Weighing 2 1/2 tons, and stretching to 17.4 meters between its most distant rims, it is the largest and heaviest satellite ever launched into a geosynchronous orbit.

When the TDRSS is completed with the two other satellites, almost uninterrupted voice and data exchanges will be routinely possible between the Earth and orbiting U.S. Shuttles—all with only one Earth-based communications station.

The system will also allow nearly continuous command and telemetry communications between ground control centers and unmanned, automated research and applications spacecraft, orbiting up to several thousand miles above the Earth. The three TDRSS satellites will orbit more than 150 times as high as the Shuttle, which usually remains below 480 kilometers, and many times as high as most other low-orbiting U.S. research and applications craft. These new TDRSS satellites can accommodate nearly all U.S. low-orbit communications traffic.

Each TDRSS satellite is launched from the Shuttle. The satellite's solar panels and antennas are compactly folded as it is stowed in the Shuttle's cargo bay. After the Shuttle attains orbit at an altitude of about 280 kilometers, its cargo bay doors open, and the satellite is



When completed, three stations (East, West, and Central) will cover most areas of the globe with communications service. All this will be accomplished with the use of only one Earth-based station. Courtesy of NASA.

ejected.

After the Shuttle moves a safe distance away, the satellite's attached booster rocket, known as an "Inertial Upper Stage," ignites and lifts the satellite to its geosynchronous orbit. There, the satellite detaches itself from its booster, and then the solar panels and antennas unfold.

When unfolded, the satellite measures 17.4 meters from the outer age of one solar panel to the outer edge of the other, and 14 meters from the outermost edge of one dish antenna to the outermost edge of the other. The satellite is allowed to drift—assisted by its attitude control thrusters—to the position assigned to it in orbit.

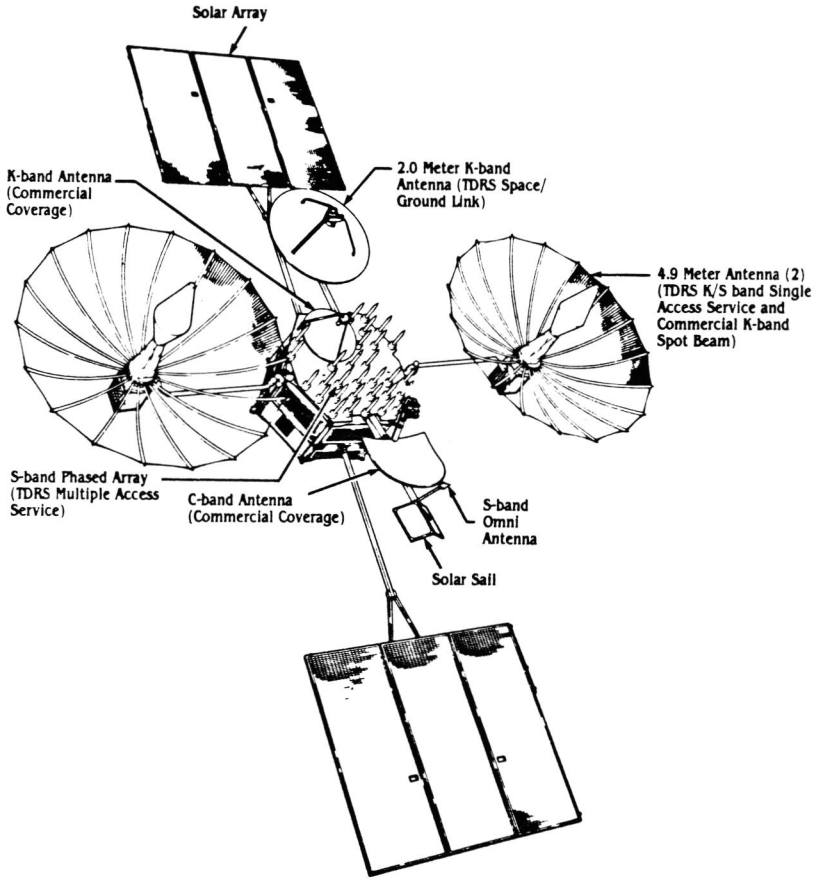
The Space Network's first satellite—the "East Satellite"—is on station above a point at the equator near the city of Fortaleza on the northeast coast of Brazil (41 degrees west longitude.

The system's second satellite—the "West Satellite"—is to be positioned above the equator north of the Phoenix Islands in the mid-Pacific Ocean (171 degrees west longitude.)

The third satellite—the "West Satellite"—is to be positioned above the equator north of the Phoenix Islands in the mid-Pacific Ocean (171 degrees west longitude).

The third satellite is to be used as a spare, and will be positioned between the others. Its precise location has not yet been selected, but it will be above the equator, probably close to the border of northwestern Brazil and Venezuela. There it will be kept largely inactive as a backup.

The new satellite—like its two companions which are to join it—is a "repeater." It neither processes nor alters any communications. It functions more like a switchboard in orbit. Its "uplink" or "forward" channels receive transmissions from the ground, amplify them, and retransmit them on another frequency to the orbiting spacecraft to which they are addressed. In its "downlink" or "return" mode, the new satellite receives transmissions from a spacecraft, amplifies them, and retransmits them to the ground terminal.


Solar Array
K-band Antenna (Commercial Coverage)
2.0 Meter K-band Antenna (TDRS Space/ Ground Link)
4.9 Meter Antenna (2) (TDRS K/S band Single Access Service and Commercial K-band Spot Beam)
S-band Phased Array (TDRS Multiple Access Service)
C-band Antenna (Commercial Coverage)
S-band Omni Antenna
Solar Sail

A TDRSS satellite looks like a windmill, having four arms or paddles. The parabolic dish antennas measure 4.9 meters in diameter, while the solar arrays provide power for the satellite. Courtesy of NASA.

All communications between a TDRSS satellite from or to the Earth pass through the satellite's 2-meter-diameter dish antenna. This antenna, near the satellite's hexagon central structure, is dedicated to Earth-to-space and space-to-Earth traffic.

When the satellite receives transmissions from the ground terminal, it instantaneously retransmits them through one of its two parabolic "inverted umbrella" antennas or through the array of 30 cylindrical antenna elements mounted on the satellite's hexagon central structure. The parabolic antennas and the array elements are used exclusively for communications with orbiting spacecraft.

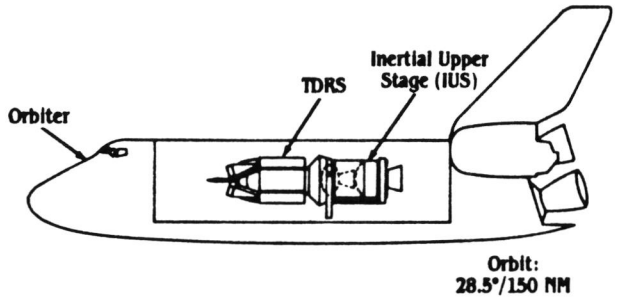
The two parabolic "inverted umbrella antennas are called "single access antennas," because each of them can be used by only one spacecraft at a time for sending or receiving transmissions. The 30 cylindrical antenna elements on the hexagon can handle communications traffic to and from up to 20 spacecraft simultaneously. They are called "multiple access antennas."

The single access antennas are steerable. They can be mechanically turned by remote control to face toward a spacecraft, and receive or transmit at very high rates. At their best performance, these antennas can receive or transmit in each second up to 300 megabytes (300 million bytes). These antennas are especially designed for use by spacecraft that generate and transmit large quantities of data to Earth.

In contrast, the array antennas, while able to accommodate up to 20 spacecraft simultaneously, can receive or transmit at only much slower rates—up to 50 kilobytes (50,000 bytes) a second.

The limit for the entire TDRSS system using two active satellites will be four simultaneous high-data transmissions and 20 at the lower data rates.

Each TDRSS satellite is made up of three modules:



The Tracking and Data Relay Satellites (TDRSs) of the space communication network will be deployed by the space shuttle. The will be carried aloft in the shuttle's cargo bay and launched with the help of an Initial Upper Stage (IUS) rocket (see figure). Courtesy of NASA.

1. The EQUIPMENT MODULE, also called the "Spacecraft Module," is in the lower part of the satellite's core hexagon. This module encompasses sub-systems that control the thrusters to keep the satellite on station and in the desired attitude. The module also houses equipment that stores and manages the power supply, and the machinery that operates telemetry and tracking equipment.

2. The COMMUNICATION PAYLOAD MODULE in the upper part of the hexagon (just below the multiple access antenna elements) contains electronic equipment that regulates the flow of transmissions between the various antennas and other communications functions. This module's electronic communications equipment forms, in a way, the "elbow" of the "bent pipe."

3. The ANTENNA MODULE consists of a platform holding various antenna including the 30 helices of the multiple-access phased-array system.

The TDRSS operates at both S-band (2025 -2300 mHz) and at Ku-Band (13700 -5115 mHz).

The Multiple Access Service (MA) operates in the S-band communications frequency and uses a fixed antenna on the TDRSS satellite to communicate with many spacecraft at the same time. Precise location of the spacecraft can be determined, but is not required for use of the MA services. The amount of data (band-width) which can be relayed to the Earth is limited to 50 kilobits per second.

The Singel Access Service (SA) is divided into two frequency bands, the S-band (SSA) and the K-band (KSA), and uses very sensitive steerable 4.9 meter (16.3 foot) parabolic dish antennas to communicate with one spacecraft at a time. Each TDRSS satellite has two such antennas. The SSA and KSA services are available simultaneously. The SA service is designed for spacecraft which requires large quantities of data to be relayed.

Communication through these antennas requires precise information about the location of a spacecraft so as to point the steerable satellite antenna to the spacecraft. Transmissions up to 6 megabits per second can be made at the S-band frequencies and up to 300 megabits per second in the K-band frequencies. Stepping motors in the arm and base of each antenna move them to follow the motion of the spacecraft with which they are communicating.

Each antenna responds independently to steering commands from the TDRSS White Sands Ground Terminal. To reach the maximum data relay capacity a spacecraft also needs to be equipped with a steerable high-grain antenna.

(For example, Landsat 5 is equipped with 1.8 meter parabolic antenna and transmits its Thematic Mapper data to TDRSS at 84 megabits per second. The Space Telescope will have a 1.3 meter antenna with a data rate of 1.024 megabits per second on the S-band.)

The space-to-ground link (SGL) antenna is a gimballed 2-meter (6.6-foot) parabolic reflector on the end of a fixed arm. It provides high-power K-band SGL communications between the TDRSS satellite and the White Sands Ground Terminal. All data to and from spacecraft serviced by the TDRSS flows through the antenna.

The White Sands Ground Terminal provides the following equipment and services:

- Three 18-meter K-band antennas serving the space-to-ground link for the two active TDRSS satellites and the backup satellite. An S-band telemetry and command antenna for communications with the spare satellite. Several other antennas for simulation and calibration of spacecraft to test and adjust their compatibility with the TDRSS network;
- Central radio frequency receivers, transmitters and associated RF signal processing equipment necessary to receive and process data streams from spacecraft and to prepare forward signals for transmission to these spacecraft. Equipment is maintained to separate up to 20 signals from the MA phased array outputs and the properly prepare MA forward commands for transmissions to specific spacecraft communicating through the MA system;
- The software to determine range and range rate tracking data measurements from spacecraft communications signals. These measurements are required for the determination of spacecraft locations and orbit parameters. The information is used to steer the TDRSS satellite's SA antennas for

communication with these spacecraft;

- Computer software to receive service requests from NASA and the convert these into equipment allocations and configurations through which these requests can be executed;
- Computer capability to monitor TDRSS satellite operations and to warn signal controllers when action may be necessary. Instruments for these functions are housed in the equipment and office buildings at White Sands. When the Space Network is complete, it will provide global coverage except for one remaining gap. Even the strategic placement of two satellites cannot give 100-percent coverage for low-orbit spacecraft. That gap exists on the side of the Earth opposite the midpoint between the two satellites. Thus, a region over the Indian Ocean stretching from the Earth's surface up to an altitude of 1,200 kilometers is not within view of either satellite. The curvature of the Earth blocks the view. Spacecraft passing through that zone at altitudes of less than 750 miles will not be able to have communications contact via the Space Network. That relatively narrow "Zone of Exclusion" stretches for slightly less than 350 kilometers on the Earth's surface, but shrinks with increasing altitude. Spacecraft in orbits above 1,200 kilometers are unaffected.

When it is fully operational, NASA's TDRSS will provide almost continuous communication between space shuttles in orbit and the ground. Just as communications satellites have shrunk the globe, TDRSS will bring many areas on the globe closer to one another. In addition, when the planned space station becomes operational, TDRSS's digital data links and other state-of-the-art technologies will increase manyfold our capability to develop the commercial, industrial, and scientific potential of space. ■

VSAT

Continued from page 4

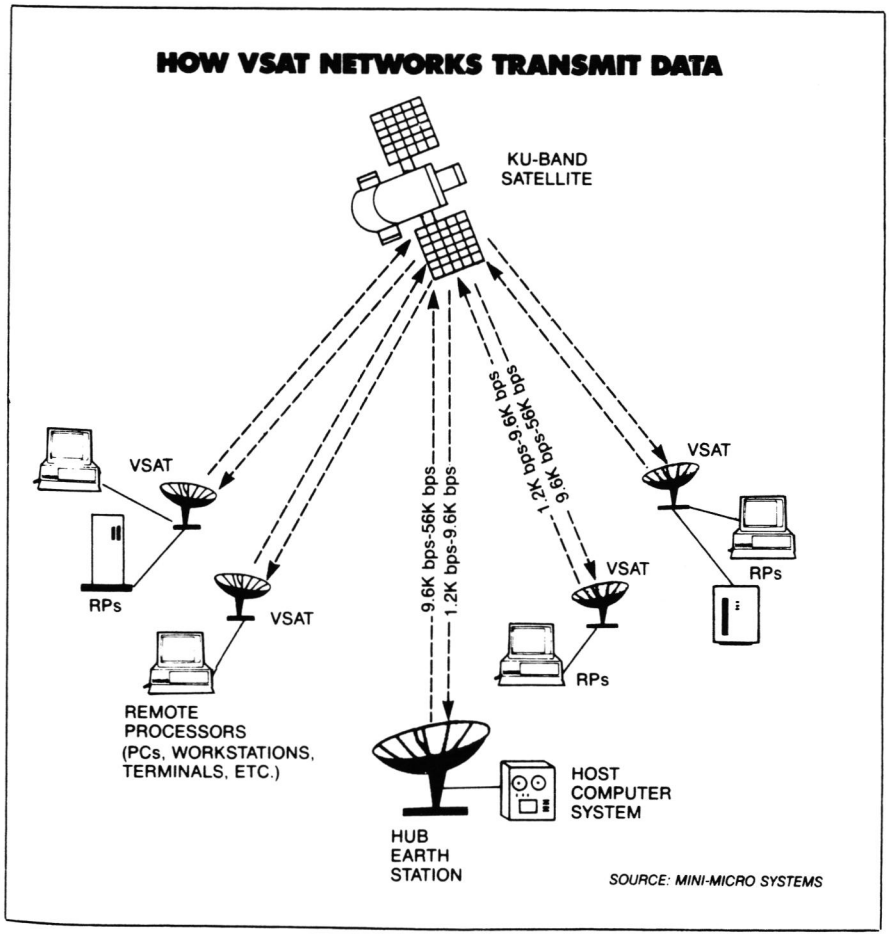
Several companies already provide interactive data services by satellite. For example, GTE Spacenet Corporation under the Skystar-200 label can transfer data from a central earth station to remote locations at a rate of up to 56K bits per second (bps). Similarly, ATT Communications began their Skynet Star Network service, which uses satellite transponders to transmit data up to 56K bps.

With the idea of utilizing satellites to transmit information came the discovery of a cheaper, smaller and advantageous earth station called Very Small-Aperture Terminals or VSAT. VSAT is not affected by the interference of microwave systems on earth; therefore, it proves advantageous for densely populated areas where a large concentration of potential businesses can make use of it.

Based on a "star" configuration, the VSAT network has a primary central earth station that controls data traffic and basically manages the whole network. Meanwhile, remote VSATs receive data from or send data to this central station. The station can then determine whether data should be stored by the host computer or sent out to other VSATs.

Users can now bypass the charges of local telephone companies and save 20%-25% using VSAT. Data can travel directly over large areas and reach customers directly. So, say goodbye to conventional telephone lines, and give a warm welcome to the VSAT network using communication satellites.

—Lilimar Z. Avelino



In a VSAT (Very Small Aperture Terminal) "star" configuration, a central hub station transmits data to remote VSATs at high speeds, using communications satellites. Courtesy of Mini-Micro Systems.

"Dr. Tom" Becomes CMEE's Newest Prof

"Let's find the answers that we don't know about "Dr. E. Thomas Moyer, also known as "Dr. Tom", has become one of the new full-time faculty for the Mechanical Engineering department this semester. He has been working in the university since 1982 as a research engineer and part-time instructor.

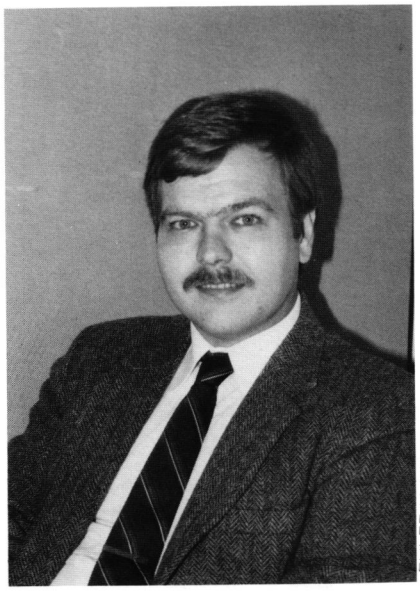
He received his B.S. in Physics from Moravian College and finished his graduate doctoral work in Applied Mechanics at Lehigh University. He is also consulting as a professional engineer. He is currently working on three different types of research including " Modeling of chip formation during manufacturing process".

One of his goals in this university is to motivate undergraduate students to go to graduate school and motivate more full-time graduate students to get involved in research.

He also would like to fully integrate computers into Mechanical and Civil Engineering curriculum. Dr. Moyer pointed out, "It is important for a student to use the computer as a routine tool just as a calculator or slide rule."

He likes to teach Numerical Methods, either on the undergraduate or graduate level. He has had articles printed in many publications including International Journal of Engineering Fracture Mechanics. Dr. Moyer is member of ASME, SES, ASM and ASTM. His hobbies are developing computer software and gardening. He is happily married and just became a house owner this summer.

—Il H. Kim



EULER V UY

Dr. E. Thomas Moyer, Jr., also known as "Dr. Tom", became CMEE's newest professor, this fall.

Correction: The photos of Anne Marie Alexander and Ken Everingham in Volume 33, No.3 were mistakenly not credited. Both were taken by Euler V. Uy.

Campus Caravansary Opens on G Street

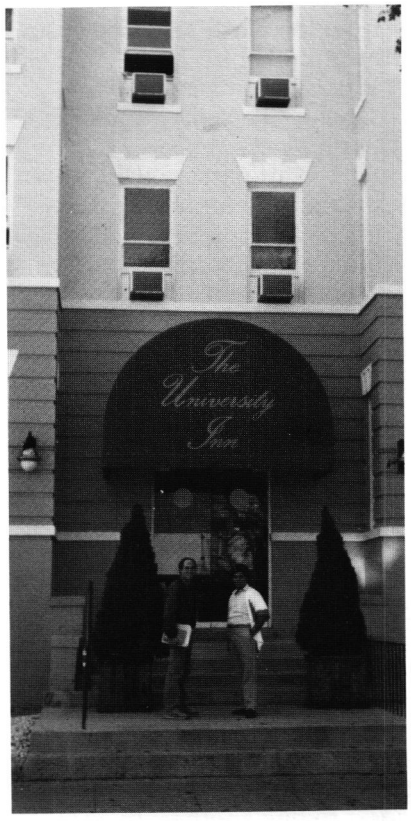
IF you're looking for lodging convenient to the campus for family members or friends for graduation, look no further. The University Inn has recently opened its doors in the midst of our campus. The only problem will be getting a room, it's already a popular place.

The inn which is located near 21st and G streets offers travelers comfort and warm surroundings at very reasonable rates on a nightly, weekly or monthly basis. Mr. Peter Weaver, owner of the Inn, claims they cater to a wide variety of clients from full time students and visiting faculty members to employees at the World Bank or the State Department. working in D.C on temporary assignment. Sometimes referred to as a "Guest House", the Inn occupies five floors, equipped with 124 modestly furnished rooms with single or double beds. A furnished lobby with complimentary coffee and tea service is available to all guests, and any problem that may arise can be handled by the front desk, which is manned 24 hours a day.

All rooms come standard with a bed, dresser, phone, heating, air conditioning and coin-operated washers and dryers located in the basement. Fifty-nine rooms are equipped with color televisions. The remaining 65 rooms are reserved for students and do not include the televisions.

Students must sign a one-year lease, of which four months are customarily paid for in advance. This is the equivalent of one semester's lodging.

Since the grand opening on last August 15th, "the occupancy rate for the first month was 100% every night and has presently leveled off



Armen A. Sahagian

The newly-opened University Inn offers one-hundred twenty-four single or double rooms, on its five floors. Here, two eager GW students seem ready to stroll in and reserve space. Can you guess who they are? (answer in next issue)

to 85 percent," according to Mrs. Jean Strickland, general manager of the inn. She further commented that "there have been no major complaints by customers of rowdy college students, but some of the residing students of the Inn complained about loud music generated by other students living in the complex."
Weaver, a businessman from England, has created a housing establishment which caters to the needs and desires of many who seek a comfortable and relaxing environment and which does not place a financial burden on them. In the near future, he plans to include a continental breakfast and laundry service to his guests. There's no doubt that this "caravansary" will become a first rate, popular inn in the future.

—Armen A. Sahagian

MECHELECIV Cited for Excellence by Columbia University Group

MECHELECIV is proud to announce that it received a Medalist Award from the Columbia Scholastic Press Association, for issues published in the academic year 1985-6. The CSPA is headquartered at Columbia University, in New York City.

The magazine earned an automatic First Place Award, with a score of 935 points out of a possible 1, 000, total. According to the CSPA scorebook, "a Medalist Award is granted to publications selected from the First Place ratings for special qualities evident to the judges, characterized as the personality, spirit, or creative excellence of the entry. Usually, only the top 10 percent of entries receive a Medalist Award."

MECHELECIV also captured a special All-Columbian Award, in the category of Editorial Goals and policies. Again, according to the CSPA scorebook, "All-Columbian Awards are given to magazines for superior achievement in Concept, Content, Design, or Creativity."

In the words of the evaluating judge, "The publication has become cleaner and more assured [than the previous year's]—more dynamic and attractive. " The judge commented favorably on the magazine's reporting of significant issues and down-to-earth style, saying that "in a magazine like MECHELECIV, it would be especially easy to get TOO technical and sophisticated." The judge also suggested that the magazine introduce more editorial content and debate on relevant issues, something which we hope to carry out this year.

—The Staff

COURTESY, AKBAR KHAWAJA

The annual Engineer Alumni Picnic, held on Sept. 27 and co-sponsored by the Engineers' Council, was a fun time for all. Pictured left to right are Prof. Douglas L. Jones, Akbar Khawaja (Engineers' Council President), Mary O. Jones (EAA Board member), and Khalid Juhany (Engineers' Council Vice-President).

SEAS BRIEFS

• Later this fall, SEAS will take a big step into the future with the arrival of our first robot. The school has purchased an ADEPT robot to be used primarily for teaching purposes. This was done to aid the new manufacturing program, introduced last year.

The $51, 000 robot has three degrees of freedom. Its motion will be controlled through both programmable and manual means. A course involving use of our version of R2D2 will be given this spring.

• ATT recently awarded a grant totaling about $250, 000 in equipment and software to two SEAS professors. Professors Garcia and Rotenstreich received the award to carry out research work and teaching in artificial intelligence and software engineering.

The grant includes three 3b2-400 UNIX computer systems, twelve ATT UNIX PC's (7300's), six 5620 Graphics workstations, as well as utilities and language software. The equipment will be placed in the SEAS Computing Facility in Tompkins Hall.

—Jeff Winbourne

FOR YOUR INFORMATION

MECHELECIV encourages all students, alumni, faculty and staff of the School, and our other readers to contribute to or join the magazine and avail of this unique opportunity for organizational, journalistic and artistic experience, as well as receive exposure and recognition.
For more information, please call (202) 676-3998 or write to MECHELECIV.

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